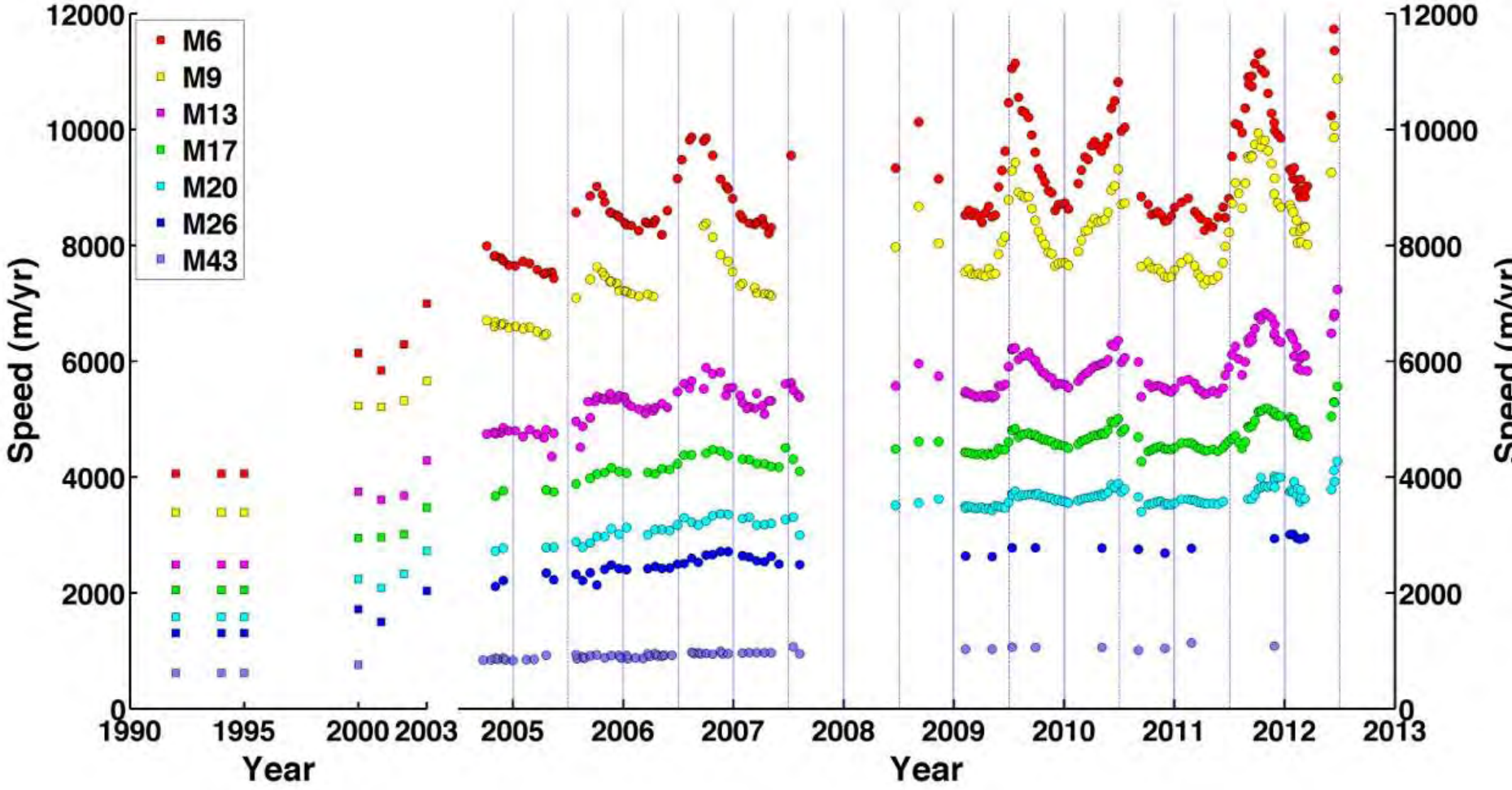
Overview of Land Ice

Mark Fahnestock + …
University of Alaska Fairbanks


1971

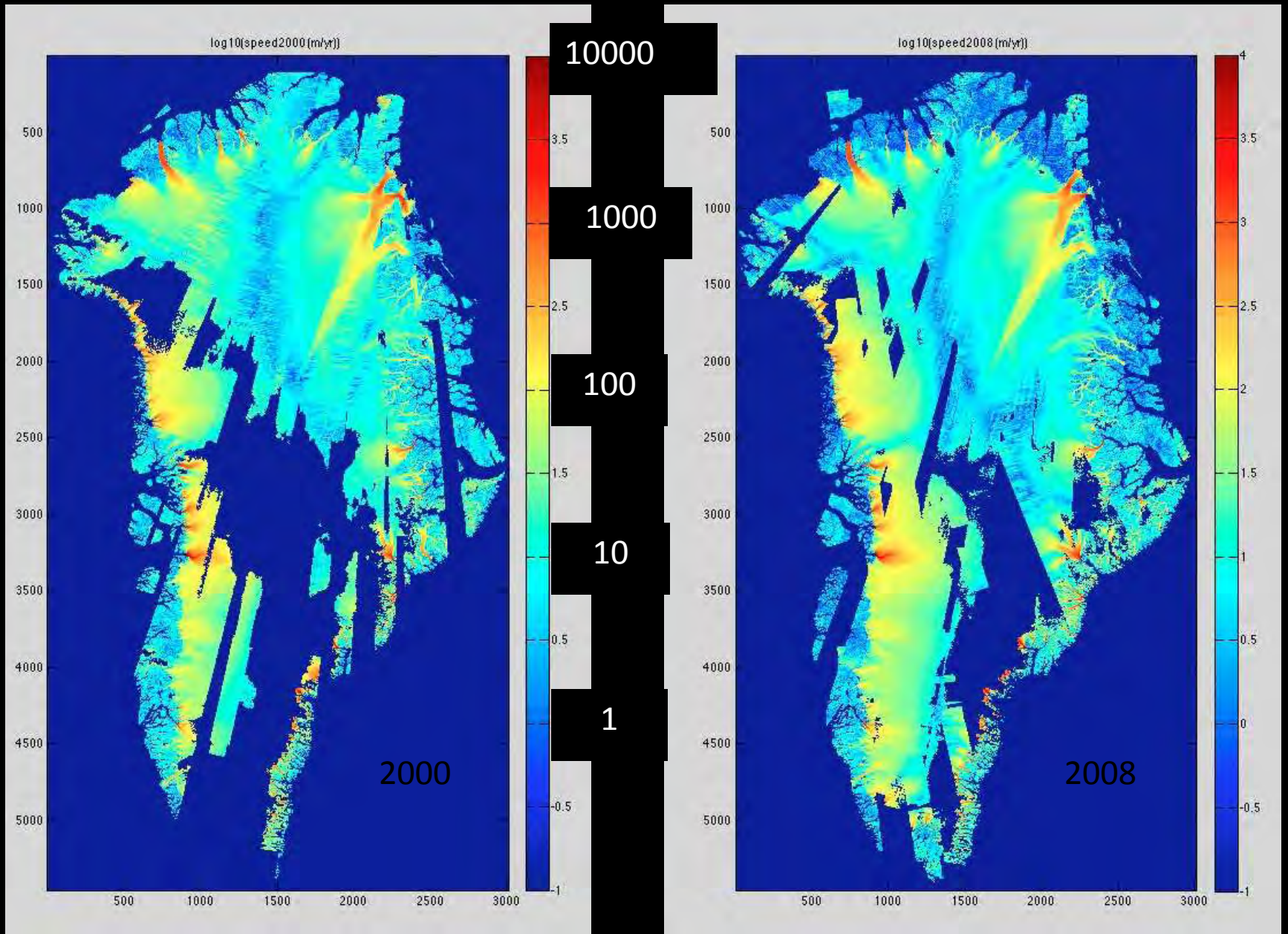
Flow speed of Jakobshavns Isbrae, West Greenland



Joughin et al. 2012

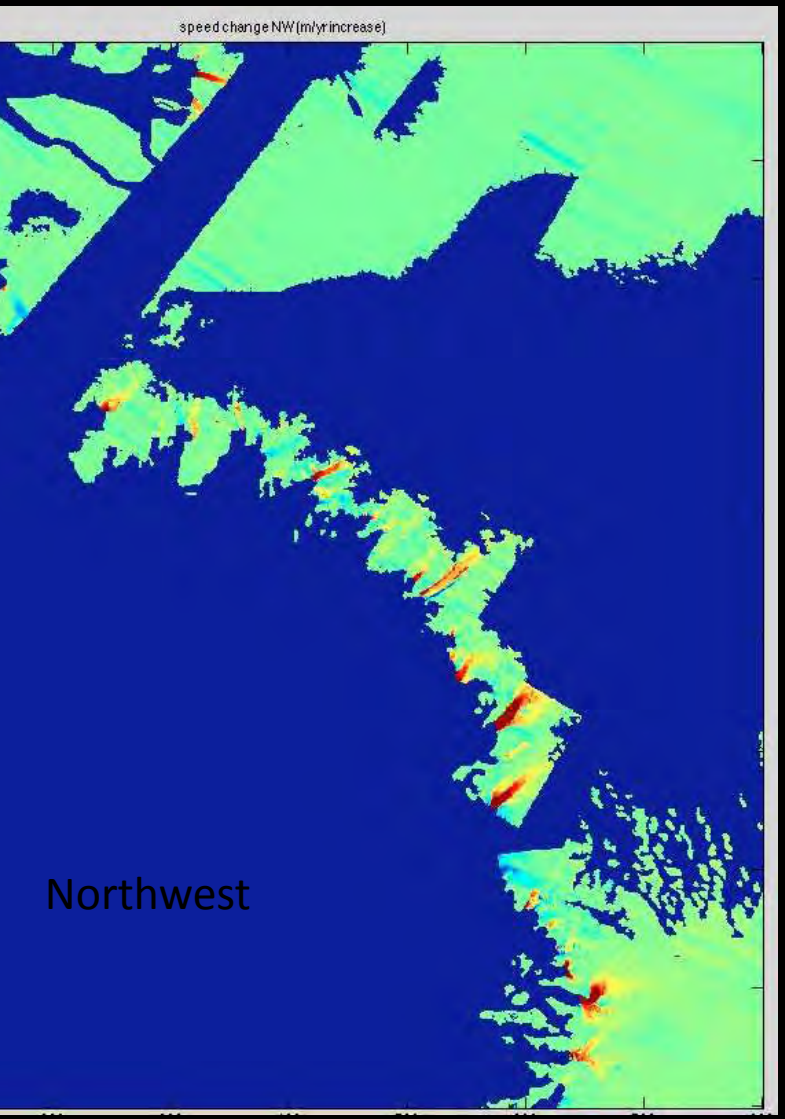
Ice Flow Speed from InSAR (log scale m/yr)

Ian Joughin UW



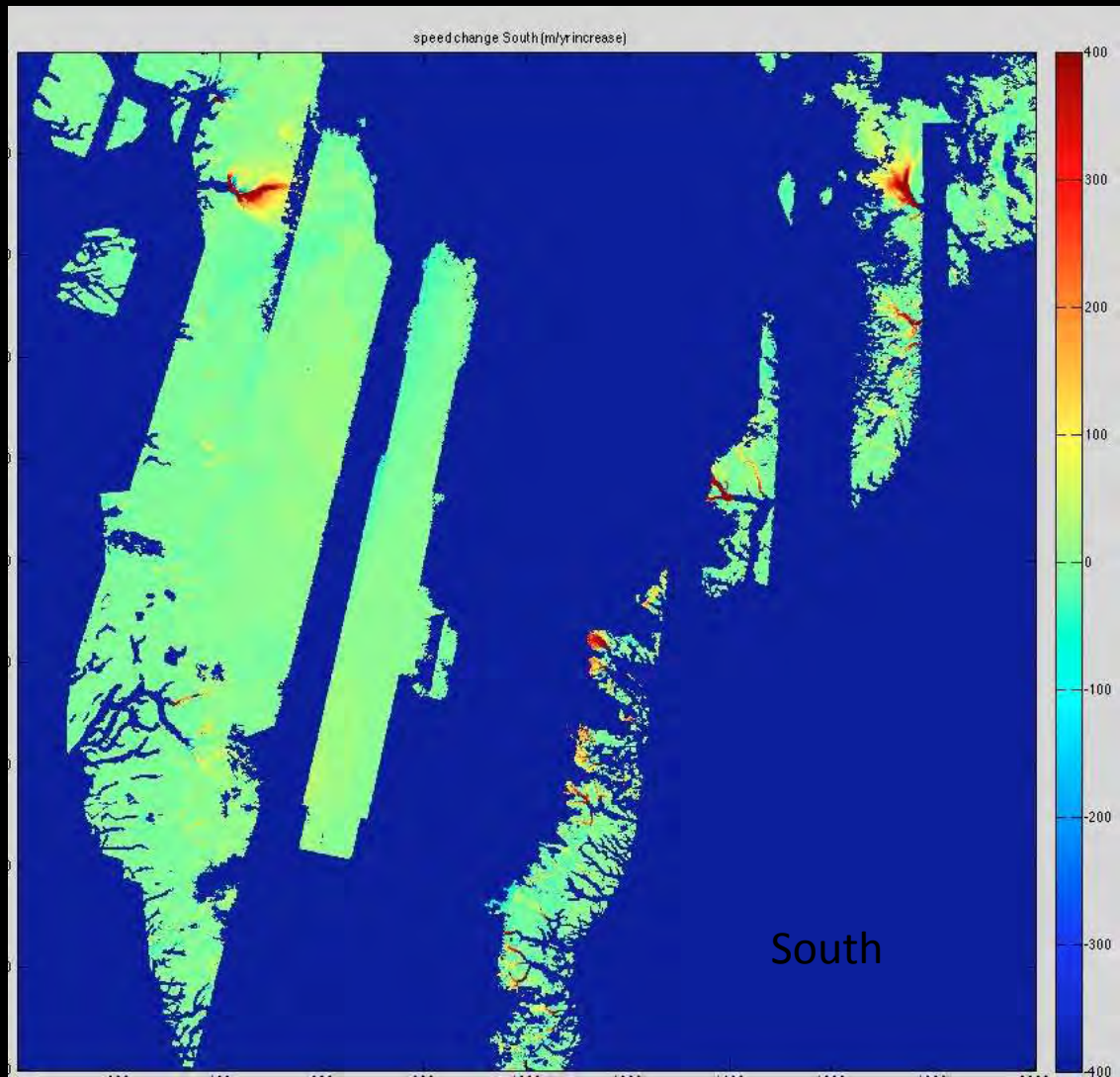
2008 – 2000 Change in Ice Flow Speed from InSAR (m/yr)

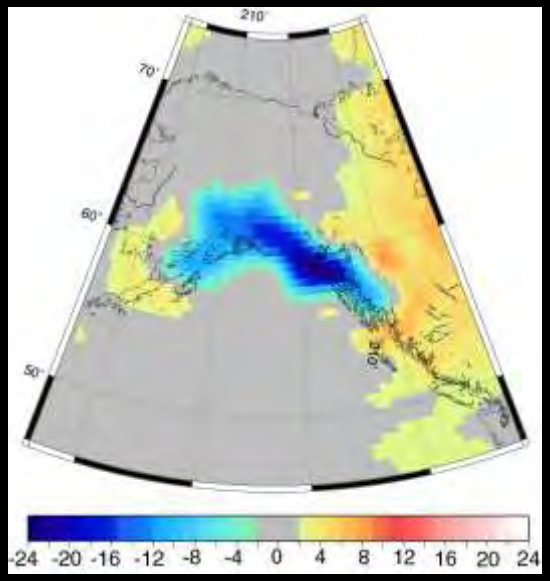
Ian Joughin UW



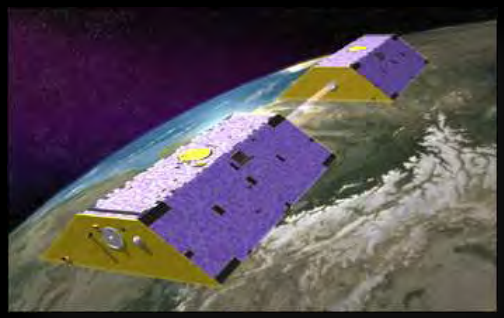
Few have slowed

Many outlet glaciers have accelerated

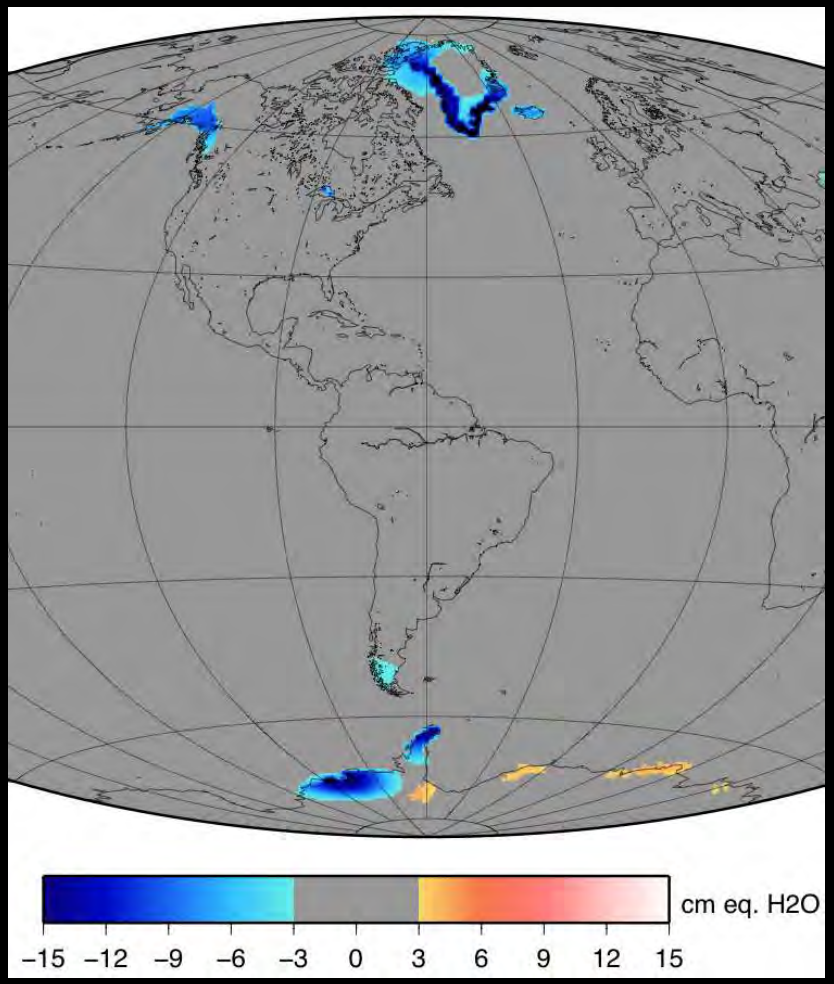


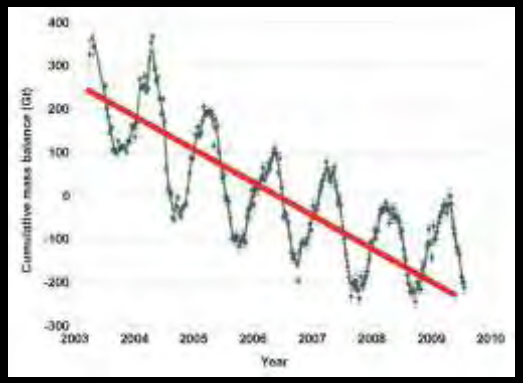


GRACE
Gravity Trend
Global Ice 1-arcdeg Mascon Solution



Luthcke et al.
J. Glac, 2013
NASA/GSFC



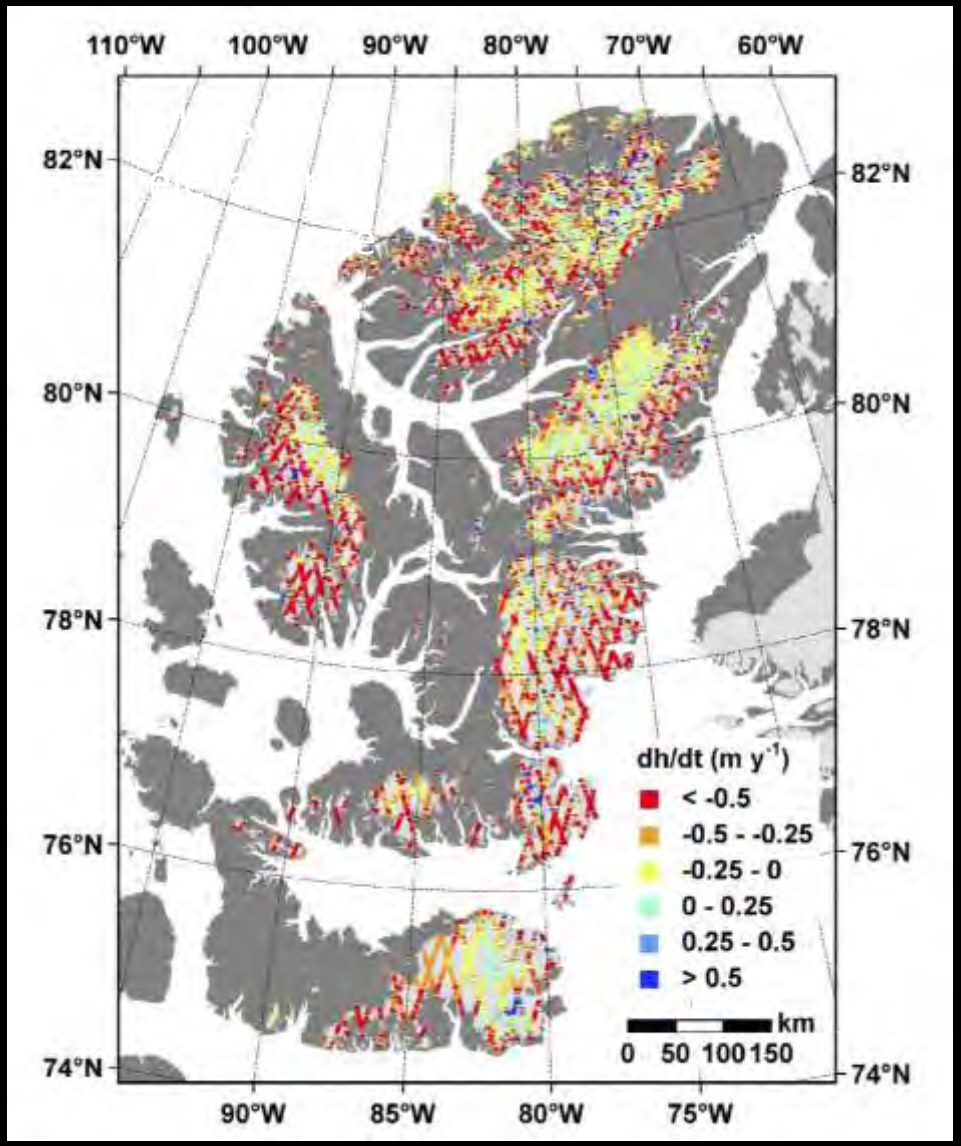


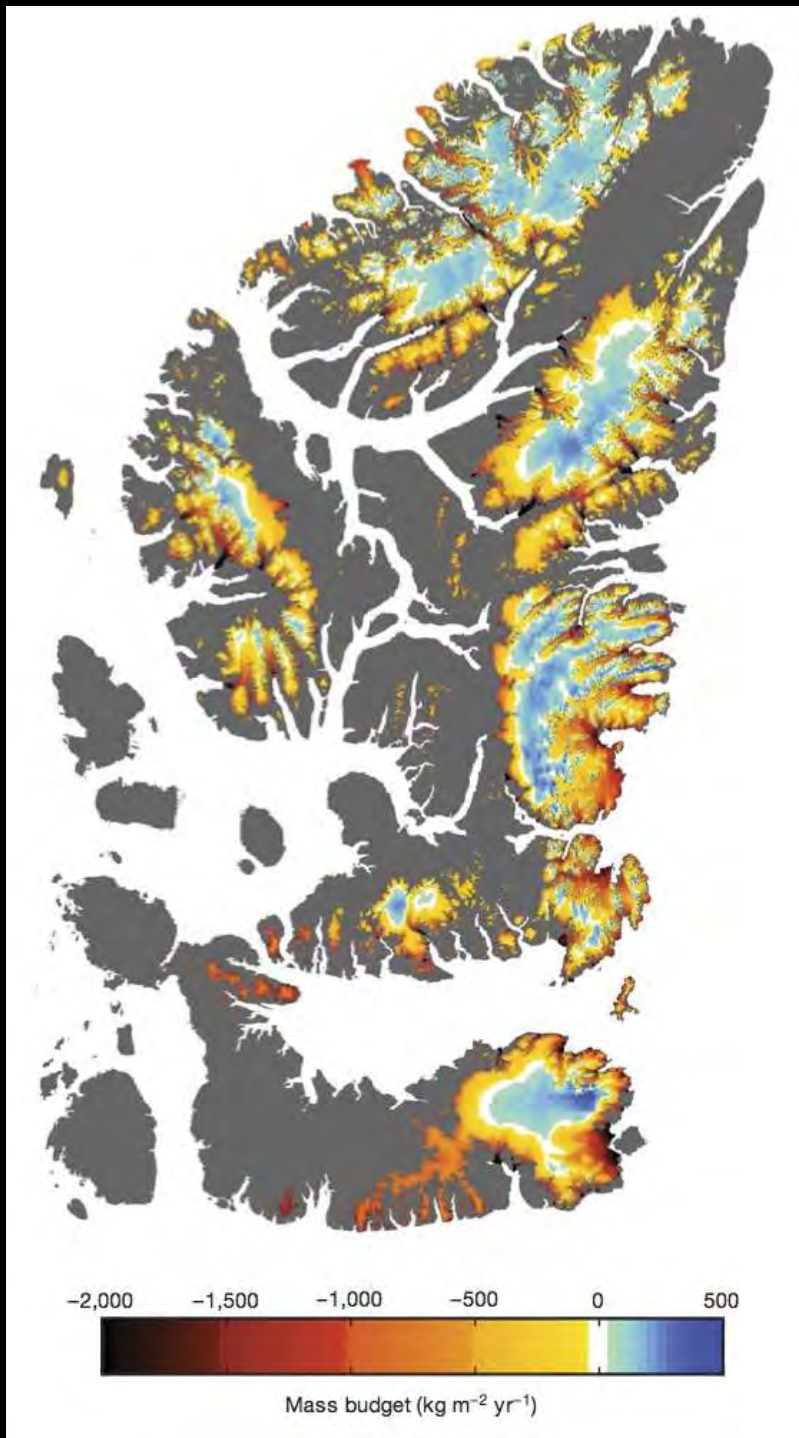
Alaska glacier changes from satellite gravimetry: 2003-2009

Total: -64.2 +/- 5.0 Gt/yr
0.17 mm/yr sea level

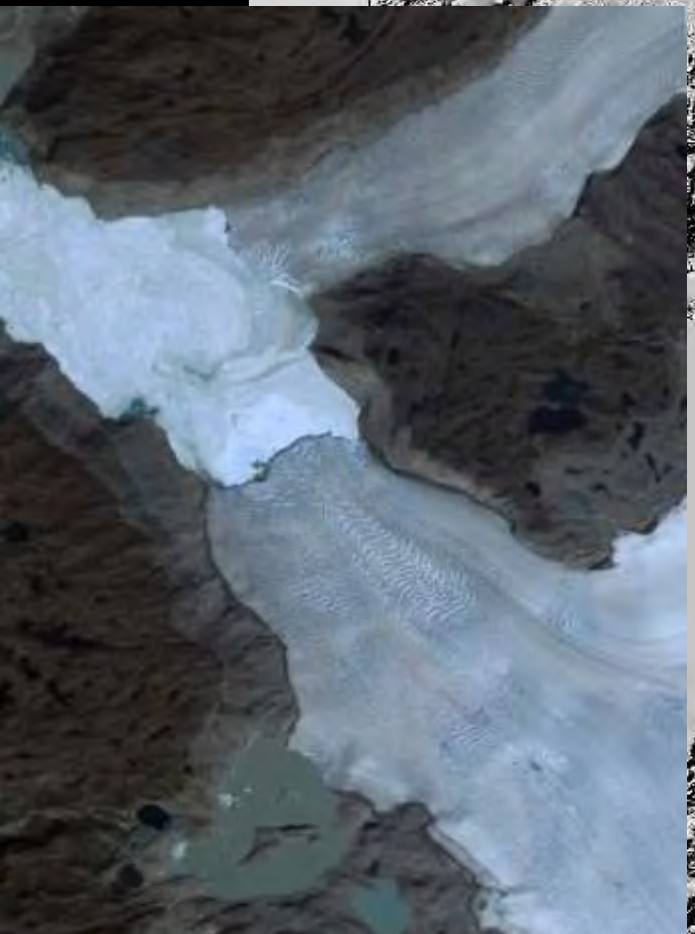
Sharply increased mass loss from glaciers and ice caps in the Canadian Arctic Archipelago

Alex S. Gardner[1,2], Geir Moholdt[3,4], Bert Wouters[5], Gabriel J. Wolken[6], David O. Burgess[7], Martin J. Sharp[1], J. Graham Cogley[8], Carsten Braun[9] & Claude Labine[10]





Elevation change 2008 – 1985 DEMs



What are the big science drivers?

- Measuring present change

  Δ mass

  Δ elevation

  Δ speed (discharge flux)

  Δ surface melt (& accumulation)

  Δ ocean-driven melting (+T, +fjord circulation)

  All in compatible, interconnected ways…

What are the big science drivers?

- Understanding what drives change:

  Why does a glacier flowing 20 m/day care about a few meters of melt a day on its front?

  Do atmospheric models capture the magnitude, timing, and location of surface melt? accumulation?

  What drives grounding line retreat and acceleration on large tidewater outlet glaciers?

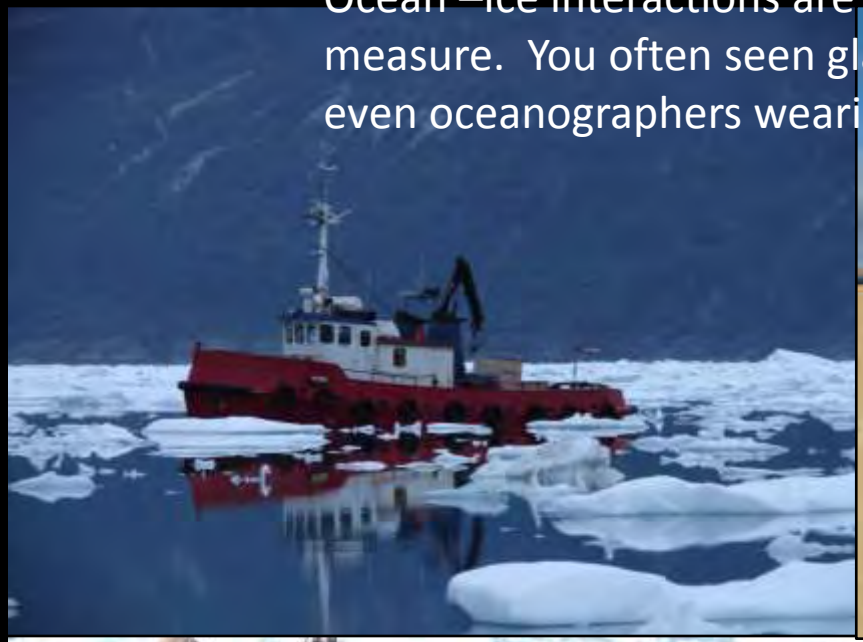
  Can ice flow models reproduce observed changes?

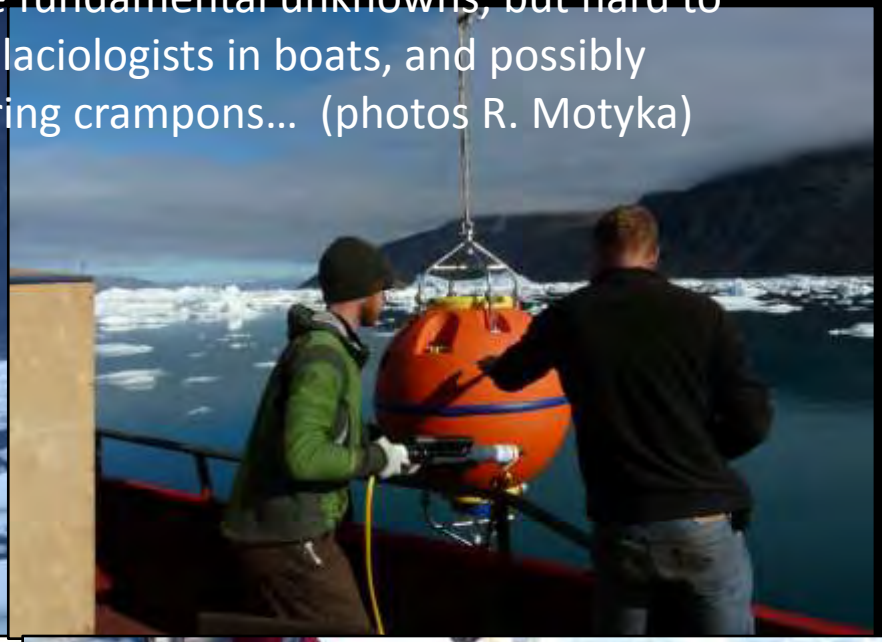
Can models reproduce observed changes?

Are model domains well enough defined (bed models, initial states, present basal conditions under the ice?) (No – resolution of outlet systems needs large improvements in Antarctica, AK and Canada, and significant continued effort in Greenland; we don't measure basal conditions, etc.)

Do we know the physics? (role of calving; ocean-driven melting of ice fronts; grounding line retreat; role of water in basal sliding) (these are open topics of present research; many are measurement or access limited)

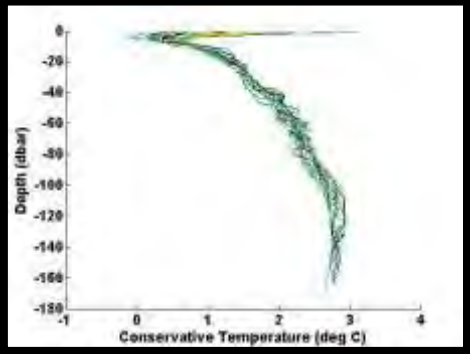
Ocean –Ice interactions are fundamental unknowns, but hard to measure. You often seen glaciologists in boats, and possibly even oceanographers wearing crampons… (photos R. Motyka)

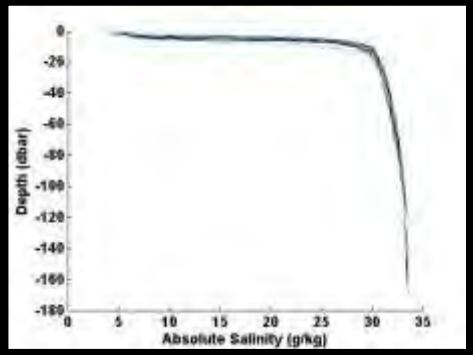


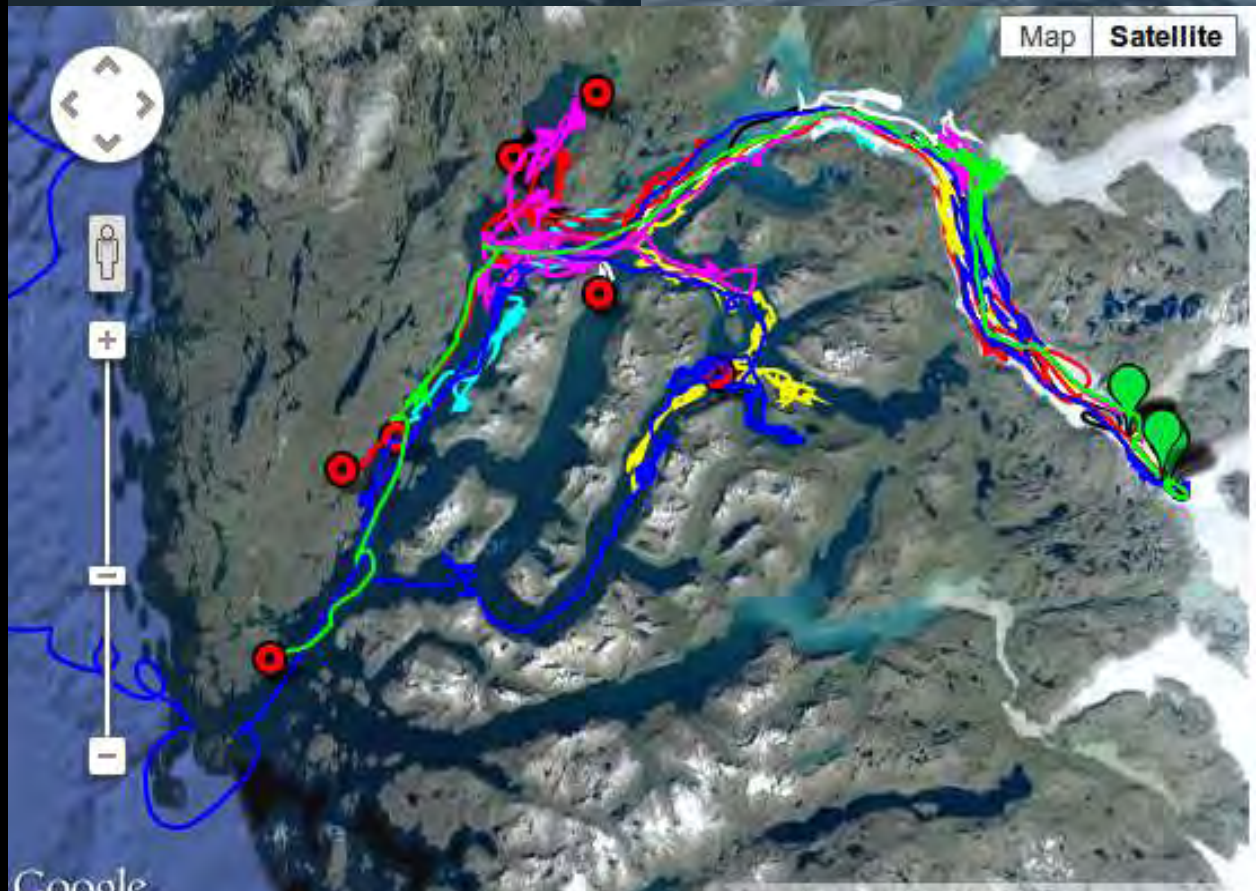


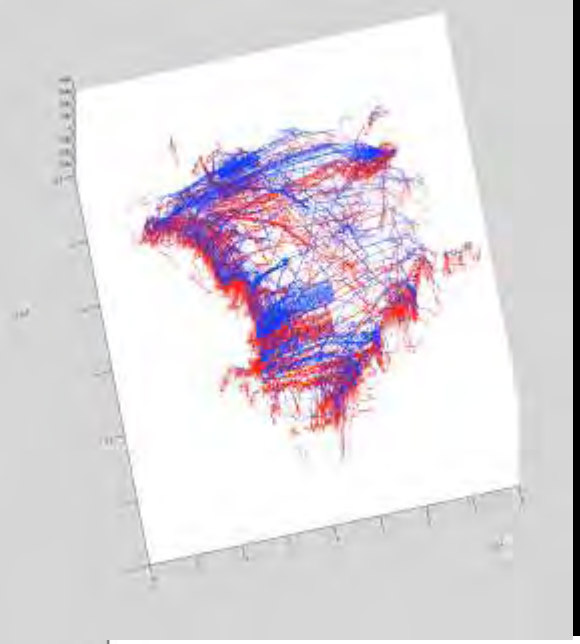
Salinity/temperature surface drifters

The upper 15 m is hard to measure…





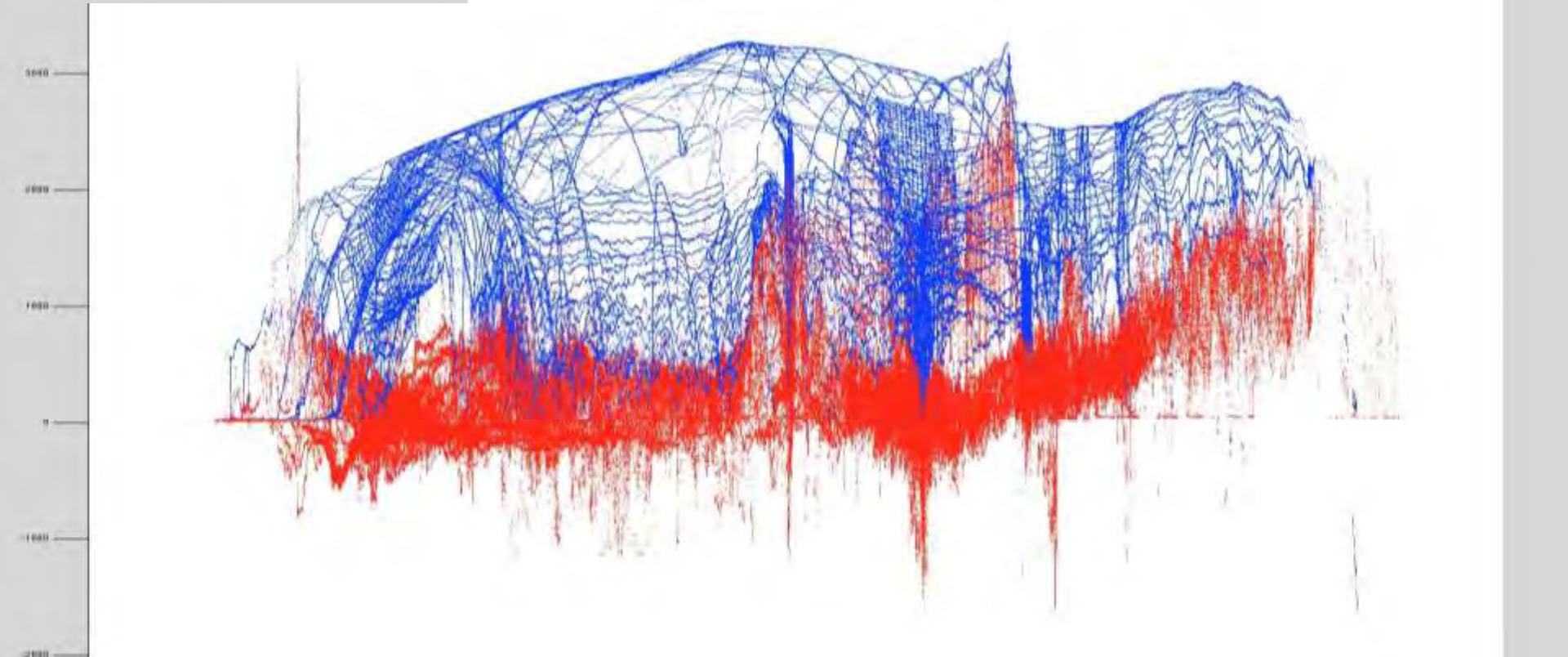




How big an issue is this ice/ocean interface?

Surface (blue) and bed (red) elevation
(NASA IceBridge/CRESIS radar)

V V V view from west V V V

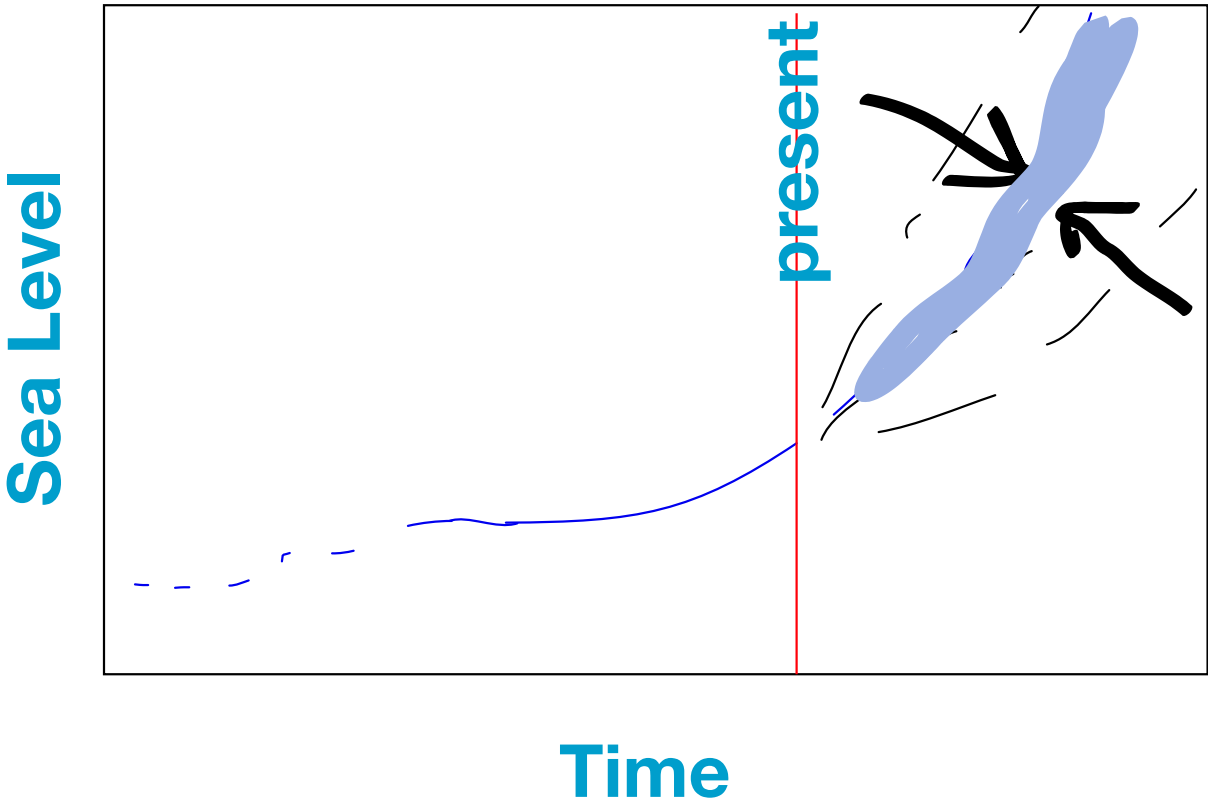


Broen over Watson River i ruiner 12. juli 2012

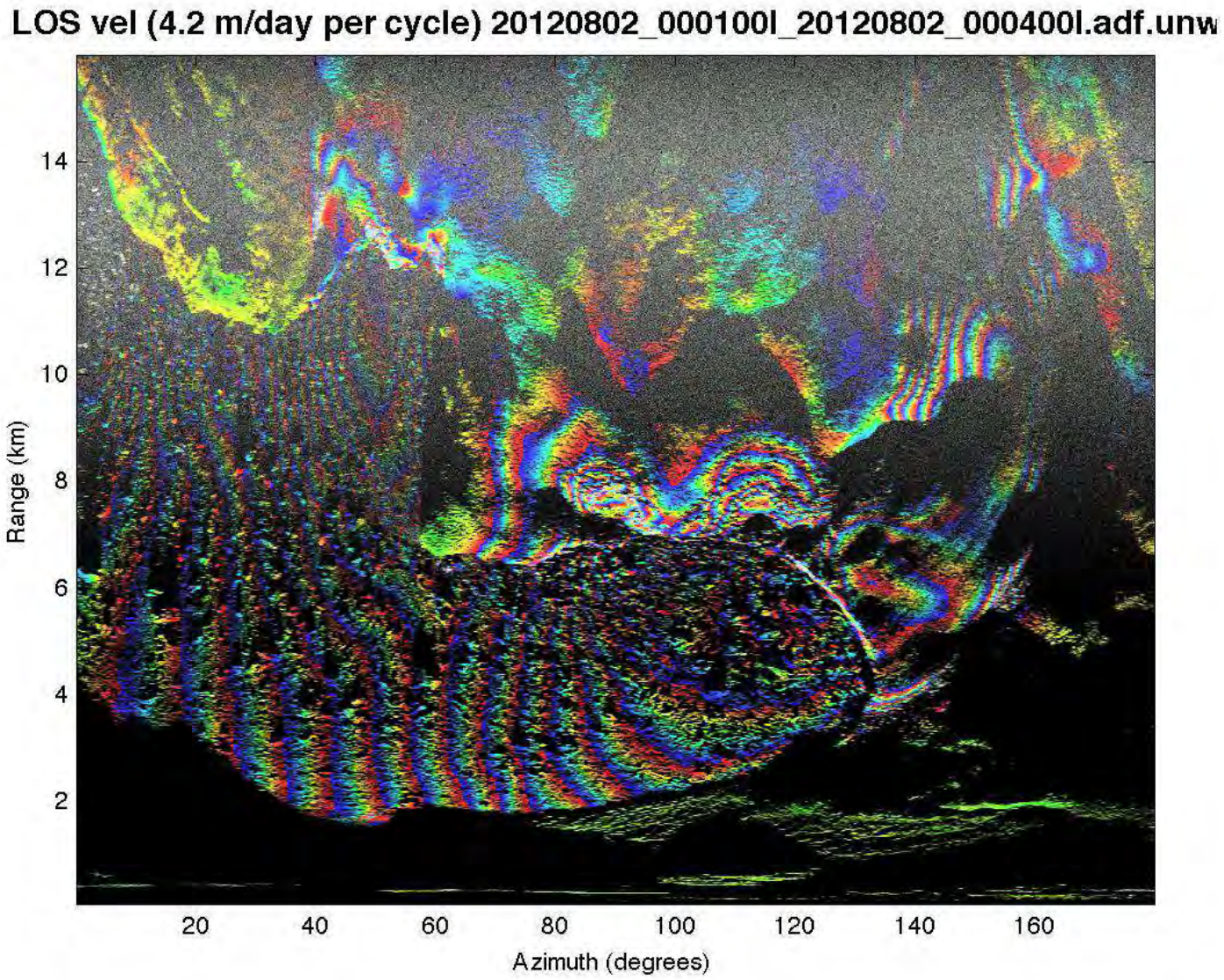

The combination of sun and warm katabatic flow can melt up to 10 cm/day over large areas.
This will be more common in the future, in Greenland as well as in Arctic Canada.

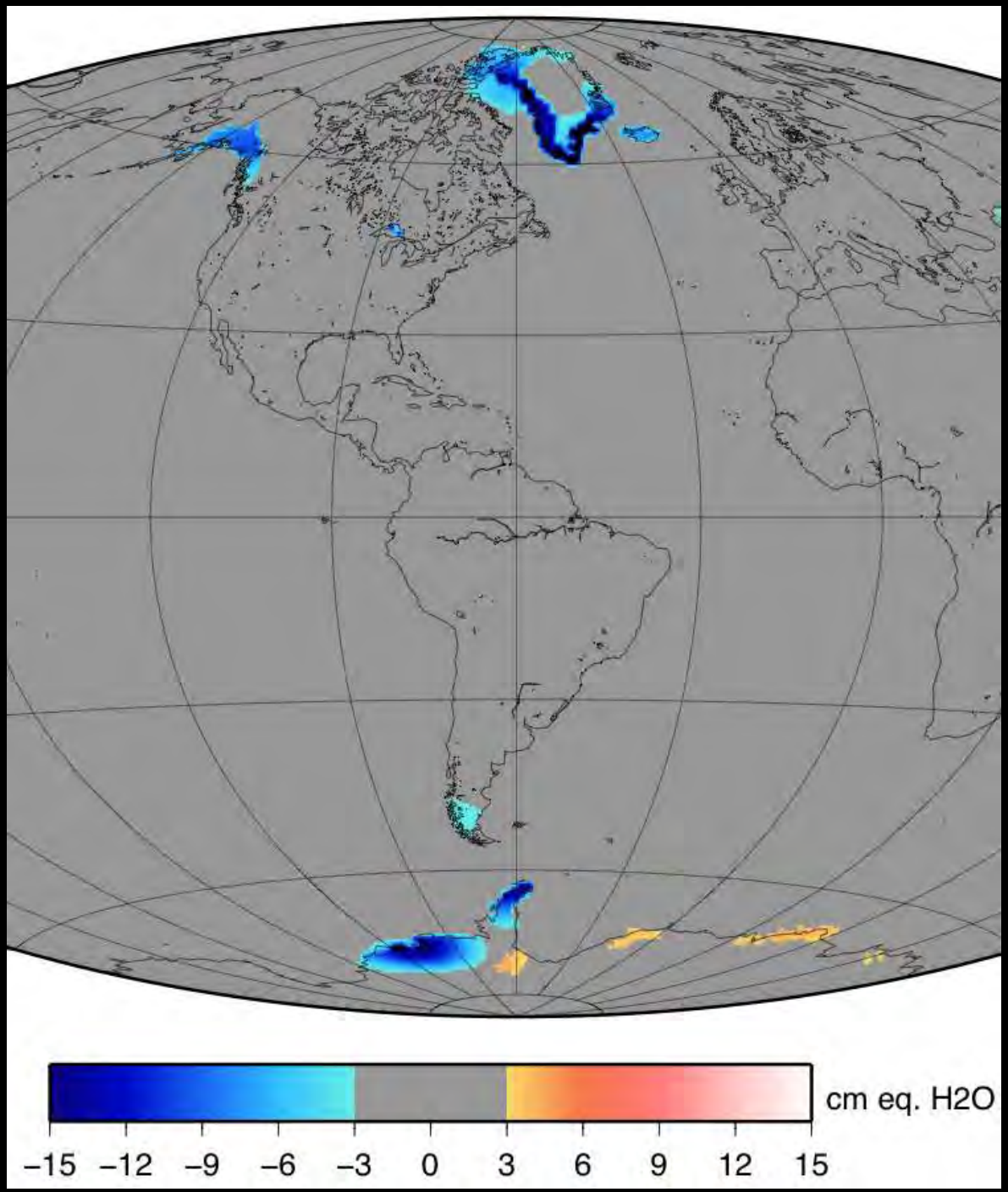
Holy Grail?

- Predicting the Land Ice contribution to the future SLR curve – both the slope and timing of changes in slope; getting it right each year…



In the future, we could know what many glaciers are doing every few minutes…





But the changing glaciers are in hard to reach places

Land Ice

- *AGU-style talks - 12 min, 3 minutes for questions. Big-picture, integrative. Each talk will address the following:*
- - What we know/don't know; what we can measure/can't measure
- - What is currently being shared, what is isolated and needs to be shared?
- - What are the big science drivers?
- - Gaps: Data, methods, training, tools, resources
- - Holy Grail: What is measure of success?